

*Closing the Gap*

Quantification and integration in biomedical research:  
measurements and standards   emerging  
needed  
overcooked  
resisted

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## Biological research—qualitative vs quantitative

One view:

- Microbiology - taxonomy
- Cell Biology - geography
- Molecular Biology - dark vs light gel bands

Then- the rise of the -OMICS!!

*Another view:*

*Quantitative work in parallel, sometimes under the radar, now prominent, driving qualitative models*

## Quantitation has driven qualitative advances

- X-ray crystallography and NMR - biological mechanisms, drug design/development
- Optical tweezers - mechanisms of ATP-driven biological machines, energetics of biological motors
- Laser temperature jump and H-exchange NMR - rapid kinetics of protein folding
- Tandem mass spec - post-translational protein processing, epigenetics

## Biological research—qualitative vs quantitative

One view:

- Microbiology - taxonomy
  - Cell Biology - geography
  - Molecular Biology - dark or light gel bands
- Then- the rise of the -OMICS!!

- *Quantitative work is driving qualitative models*
- *Increased resolution and scale of quantitation:*
  - *raise opportunity/challenge of integration*
  - *relationships enhance richness of information*
  - *increase need/value of measurement standards, benchmarks*

## Measurements and standards: different needs in different fields

- **Genomics:** *rapid evolution of next generation technologies; FDA initiated, led MicroArray Quality Control project, built some reference materials; ~80-90% correspondence across platforms; need standard reference tools, analysis software, platform comparison benchmarks, network building tools*
- **Synthetic biology:** *using engineering principles to produce designed molecular actions/processes; need standard conditions for measuring activities of various components; need standard sets of parts with predictable relative activities under several conditions; don't overcook!*
- **Clinical research:** *need better data and standard databases (common coding conventions) for comparison and statistical analysis; need standard templated methods for collecting and portraying components of clinical care; need standard replacement for medical record notes*
- **Medical informatics/medical devices:** *need standards for device interoperability; companies are resistant; coordinate readouts to standard databases*

## Measurements and standards: Opportunities to extend integration

- *Develop a "structural biology of the cell" that positions cell components and tracks them over time*
- *Count copies of each protein in cells to relate stochasticity and regulation*
- *Measure number, size and distribution of protein complexes and aggregates*
- *Measure and track properties of cancer cells within populations of normal cells*
- *Define multiple molecular phenotypes of cells to determine molecular networks that predict complex behaviors (disease, drug response)*